PATENT ABSTRACTS OF JAPAN

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(54) SUBSTRATE FOR THIN-FILM MAGNETIC HEAD AND THIN-FILM MAGNETIC HEAD USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To improve heat radiating property of a thin-film magnetic head element and to prevent the contact of the element to a medium by successively depositing a diamond-like carbon film and amorphous alumina film to a specified thickness on a substrate.

SOLUTION: A diamond-like carbon film having 0.7 to 3.5 μm thickness and an amorphous alumina film having ≤1.3 μm thickness are deposited successively on a substrate. First, a diamond-like carbon(DLC) film 7 is formed through normal temperature plasma CVD method on a disk substrate 6 having an orientation flat face. Then an amorphous alumina film 8 is formed through RF sputtering or ECR sputtering. The amorphous alumina film 8 formed by RF sputtering or ECR sputtering has high film packing rate. Thereby, thermal conductivity is improved

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by the DLC film 7, and as a result, heat can be fast transferred to a slider having high conductivity and the heat radiating property is enhanced.

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CLAIMS

[Claim(s)]

[Claim 1] The substrate for the thin film magnetic heads which comes to carry out the laminating of the diamond-like carbon film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one on a substrate.

[Claim 2] The thin film magnetic head which comes to form a magnetic film on the amorphous alumina film of the substrate for the thin film magnetic heads of claim 1.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the substrate for the thin film magnetic heads used for the thin film magnetic head and it which are used for the hard disk drive which is the recording apparatus of a computer, a tape drive,

etc.

[0002]

[Description of the Prior Art] Conventionally, on the ceramic substrate which turns into a substrate for the thin film magnetic heads from an alumina (aluminum 2O3) and the composite of a titanium carbide (TiC) as a principal component, the insulator layer which consists of an amorphous alumina is formed by the sputtering method, and what carried out mirror plane processing of the field with the one side polish machine is used.

[0003] In order that the above-mentioned insulator layer may acquire insulation with the ceramic substrate which is electric conduction material, it forms in order to attain smooth nature further, but especially about the field coarseness of an insulator layer, in order to acquire a field important in order to form a component on it and smoother, it is processed by CMP (CHEMICAL MECHANICAL POLISHING) etc.

[0004]

[Problem(s) to be Solved by the Invention] In order to raise recording density in recent years, it is shown that MR (MAGNETRORESISTIVE) which used the magneto-resistive effect for the component of the thin film magnetic head, or GMR (Giant MR) uses, but in the case of such MR component and a GMR component, in order to raise reading sensibility, it is necessary to raise a sense current value.

[0005] Moreover, in the MR head for hard disk drives, or a GMR head, with about 1 microinch, the flying height of a head is small and is becoming close to a NIAKON baton. Therefore, the so-called thermal asperity phenomenon which the magnetic head and media tend to carry out [the phenomenon] contact sliding, and a temperature change produces in MR component section of the thin film magnetic head with the frictional heat at this time, consequently reading sensibility reduces serves as a very big trouble.

[0006] Although it is necessary to raise the heat dissipation nature of the circumference of a component in order to cancel this trouble Therefore, make

thickness of the amorphous alumina film thin and MR component is brought close to the high aluminum2 O3-TiC substrate of heat conduction. Heat dissipation nature is raised by this, or the recess by the hardness difference of an aluminum2 O3-TiC substrate and the amorphous alumina film is used, and the cure of preventing that MR component collides with a media side is performed.

[0007] However, when the thickness of the amorphous alumina film was set to 3 micrometers or less, it was inadequate in respect of withstand voltage.

[0008] Therefore, this invention person is making the diamond-like carbon film in which the both sides of thermal conductivity and a withstand voltage property were excellent compared with the amorphous alumina film cover, as a result of repeating research wholeheartedly in view of the above-mentioned situation, and it found out that this trouble was canceled.

[0009] This invention is completed based on the above-mentioned knowledge, while the object raises the heat dissipation nature of the thin film magnetic-head component section, the contact to the media side of a component is prevented, and it is in offering the substrate for the thin film magnetic heads which was further excellent in film adhesion reinforcement, electric pressure-proofing, and field grace.

[0010] Other objects of this invention are to offer the thin film magnetic head of the high quality which used the substrate for the thin film magnetic heads of this invention, and high-reliability.

[0011]

[Means for Solving the Problem] The substrate for the thin film magnetic heads of this invention is characterized by carrying out the laminating of the diamond-like carbon film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one on a substrate.

[0012] It is characterized by the thin film magnetic head of this invention coming to form a magnetic film on the amorphous alumina film of the substrate for the thin film magnetic heads of this invention.

[0013]

[Embodiment of the Invention] Hereafter, drawing 1 - drawing 4 explain the operation gestalt of this invention. The perspective view in which (a) of drawing 1 and (b) show the substrate 1 for the thin film magnetic heads of this invention, the important section expanded sectional view by cutting plane line X-X [in / in drawing 2 / drawing 1 R> 1 (a)], and drawing 3 are the important section expanded sectional views showing the layer system in which the magnetic film was formed on the substrate 1 for the thin film magnetic heads of this invention. Moreover, drawing 4 is the sectional view showing the busy condition of the thin film magnetic head 2 of this invention.

[0014] As for the slider with which 3 consists of the aluminum2 O3-TiC system ceramics, a ferrite, sapphire, etc., and 4, in the thin film magnetic head 2 of drawing 4 , MR component and 5 are media.

[0015] The above-mentioned thin film magnetic head 2 is obtained according to the following production process. First, according to the substrate 1 for the thin film magnetic heads of drawing 1 , as shown in the disc-like substrate 6 with a diameter of 2-8 inches which has an orientation flat as shown in (a), or (b), it is the 3-6 inches one-side corner guard-like substrate 6. On these substrates 6, as shown in drawing 2 , the diamond-like carbon (DLC) film 7 is formed by the ordinary temperature plasma-CVD method, and subsequently the amorphous alumina film 8 is formed by RF spatter or the ECR spatter. Incidentally about the describing [above] ordinary temperature plasma-CVD method, hydrocarbon gas is decomposed in the discharge plasma in a high vacuum, the ion in the plasma and an excited molecule are electrically accelerated to a substrate, and it forms by making it collide that it is also with such high energy.

[0016] For most above-mentioned DLC film 7, it sets in the joint form of four carbon atoms, and a diamond is SP3. He is SP3 to being an orbit. An orbit and SP2 Including orbital [both], it excels in surface smooth nature, and a degree of hardness is still higher and it excels in abrasion resistance.

[0017] moreover, the DLC film 7 has high thermal conductivity compared with the amorphous alumina film 8, and is further excellent also in electric insulation -- on

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the other hand, a front face -- it is inferior to description and easy to produce a film defect. further -- the DLC film 7 -- high [3000 or more HV] -- since a degree of hardness, surface polish is difficult and surface smoothing is difficult.

[0018] Then, in order to make the fault of the DLC film 7 complement, while forming the amorphous alumina film 8 on it and making a front face smooth by this, generating of a defect is prevented and good and high withstand voltage is made to provide.

[0019] By having formed the amorphous alumina film 8, the surface 8a becomes a very smooth field, and a magnetic film 9 is formed on surface 8a so that it may be shown subsequently to drawing 3 . pass a slicing process, an ABS side polish process, and ion milling processing (RIE processing) one by one after such a wafer process -- much thin film magnetic heads 2 are obtained simultaneously. About MR component, it is the component used by reading and forms with the ultra-fine processing technology by photograph RISOGURAFU.

[0020] the case where the above-mentioned substrate 6 is produced with the aluminum2 O3-TiC system ceramics -- 60 - 80% of aluminum 2O3 the raw material which uses 40 - 20% of TiC as a principal component -- using -- the inside of atmospheric air or reducing atmosphere -- 1600-1800 degrees C -- a hotpress -- or HIP processing is carried out and it is obtained. This aluminum2 O3-TiC system ceramics serves as a very precise sintered compact, and can smooth a front face. In addition, although the aluminum2 O3-TiC system ceramics is electric conduction material, it gives insulation by forming the DLC film 7 and the amorphous alumina film 8 on a substrate 6.

[0021] Moreover, after forming the amorphous alumina film 8, it is easy to carry out CMP processing that a film front face should be made still smoother.

[0022] By this, if a front face is expressed with the surface roughness (Ra) measured by AFM (ATOMIC FORCE MICROSCOPY), it will be made to 10A or less.

[0023] And it is good to set suitably 1.3 micrometers or less of thickness after this polish to 1 micrometer or less, and desirable at the point which will become if the

effectiveness which radiates heat on the DLC film 7 through the amorphous alumina film 8 by this becomes high.

[0024] Moreover, it is good to set suitably 0.7-3.5 micrometers of thickness of the DLC film 7 to 1-3 micrometers, and, in the case of less than 0.7 micrometers, withstand voltage falls, and if 3.5 micrometers is exceeded, it will exfoliate between the amorphous alumina film 8.

[0025] By the DLC film 7 formed by the ordinary temperature plasma-CVD method in this way, although many defects had occurred on the inside of the film, and a film front face, in the amorphous alumina film 8 further formed by RF spatter or the ECR spatter, the high membrane formation filling factor was obtained, this raised thermal conductivity as the DLC film 7 is also, consequently the twist could burn heat, it could tell and heat dissipation nature was raised to the thermally conductive high slider 3.

[0026] Moreover, the DLC film 7 also raised the withstand voltage property (the ordinary temperature resistance in applied-voltage 10V to the laminating of the DLC film 7 and the amorphous alumina film 8 is set to 1011ohms or more), it is that the surface smooth nature which was excellent in the amorphous alumina film 8 being was obtained, and the substrate 1 for the thin film magnetic heads excellent in field grace was offered.

[0027]

[Example] Hereafter, the example of this invention is explained. The alumina (the mean diameter of 99.9% of purity and raw-material powder: 0.4 micrometers) and the titanium carbide (the mean diameter of 99.5% of purity and raw-material powder: 0.3 micrometers) were used as a start raw material, weighing capacity was carried out so that an alumina might serve as and a titanium carbide might serve as 30% of the weight of a ratio 70% of the weight, about 10% of the weight of titanium oxide TiO2 was further added to the titanium carbide, and it mixed with alumina balls. Subsequently, mixed powder is fabricated and they are 1600 degrees C and 250kg/cm2. Hotpress baking was carried out by the pressure for 1 hour.

[0028] Thus, after carrying out the grinding process of the produced sintered compact to the shape of a predetermined disk type by the diamond wheel, surface wrapping processing was performed using the diamond abrasive grain. Subsequently, using diamond powder with a mean particle diameter of 0.5 micrometers, a substrate front face, a polish plate, or abrasive cloth was slid relatively, precision polish was performed, and surface roughness Ra of a substrate was made into 18A by this. In this example, the tin surface plate was used as the above-mentioned polish plate.

[0029] From originating in the membrane formation stress accompanying the following membrane formation process next, and the substrate itself deforming, shot-blasting processing is beforehand performed for a membrane formation rear face, and the flatness on the front face of a substrate is deformed into the concave surface.

[0030] And membrane formation formation of the DLC film was carried out in 1-5 micrometers using methane and hydrogen gas by RF plasma-CVD method (RF power: 500W, DC-bias:-250V) as shown in a table 1. The surface roughness Ra of such film is 28-140A.

[0031] Furthermore, the alumina target of 99.5% of purity is used. In a spatter After it forms the amorphous alumina film by the thickness of 3 micrometers and the polish liquid which made spherical alumina impalpable powder suspend in pure water performs mirror plane processing after that, The polish liquid which made spherical Seria impalpable powder suspend in pure water performed the last precision processing, and the laminating of the DLC film into which thickness was changed, and thickness (0.5 micrometers, 1 micrometer, and 1.5 micrometers) of the amorphous alumina film (film surface surface roughness [Ra]) was formed the passage of sample No.1-8. In addition, what does not form the DLC film as an example of a comparison is shown in a table 2 as sample No.9-12.

[0032]

[A table 1]

試料 No	DLC膜の厚み (μm)	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜の厚み (μm)	表面粗度Ra (Å)		加熱処理後膜剥離	抵抗値 Ω
			DLC膜	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜		
※ 1	5	0.5	140	2.8	有	10^{13}
※ 2	4	0.5	108	2.6	有	10^{13}
3	3	0.5	78	2.5	無	10^{13}
4	2	0.5	51	3.1	無	10^{13}
5	1	0.5	28	2.7	無	10^{12}
※ 6	0.5	0.5	25	2.6	無	10^{10}
7	1	1	29	3.3	無	10^{12}
※ 8	1	1.5	28	3.0	有	10^{13}

※印の試料Ｎｏは本発明の範囲外のものである。

[0033]

[0034]

[A table 2]

試料 No	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜の厚み (μm)	表面粗度 Ra (Å)	加熱処理後膜剥離	抵抗値 Ω
9	4	3．1	無	10^{11}
10	3	2．9	無	10^{9}
11	2	3．4	無	10^{7}
12	1	2．7	無	10^{6}

[0035] When the surface roughness and the resistance of the film exfoliation after heat-treatment, the DLC film, and the amorphous alumina film were measured to each [these] sample, the result as shown in this table was obtained.

[0036] About the film exfoliation after heat-treatment, each sample was heated at the temperature of 600 degrees C within the vacuum ambient atmosphere, and the desquamative state of a membrane formation phase was checked with the differential interference microscope (50 times). Moreover, the surface roughness on the front face of the outermost was measured in AFM.

[0037] About ordinary temperature resistance, 20 place / phi 4 microinches of electrodes of Ti/Au were formed in the film surface, it had in ordinary temperature applied-voltage 10V, the resistance between a film front face and the rear face of a substrate was measured using the 3 terminal method, and the minimum resistance was calculated.

[0038] a passage clear from the result shown in a table 1 -- sample No.3- of this invention -- about 5 and 7, resistance was set to 1012ohms or more, the outstanding withstand voltage was obtained, film exfoliation stops having arisen after heat-treatment further, and surface roughness Ra became 3.3A or less.

[0039] Moreover, heat dissipation nature almost comparable as sample No.9 (what formed only the amorphous alumina film by the thickness of 4

micrometers) in ** put in practical use was obtained, and when each sample of this invention produced the various thin film magnetic heads which formed the magnetic film in each sample of this invention and investigated the thermal asperity phenomenon, respectively, the generating decreased remarkably and it was convenient [a sample] in any way practically there.

[0040] however, sample No. -- since the DLC film was thick at 1 and 2, the surface roughness became large, therefore film exfoliation occurred between amorphous alumina film. Moreover, in sample No.6, since the DLC film was thin, resistance became small. Since the amorphous alumina film was still thicker at sample No.8, film exfoliation occurred.

[0041]

[Effect of the Invention] While being having carried out the laminating of the DLC film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one and raising the heat dissipation nature of the thin film magnetic-head component section on the substrate in this invention as above, the contact to the media side of a component was prevented and the substrate for the thin film magnetic heads which was further excellent in film adhesion reinforcement, electric pressure-proofing, and field grace has been offered.

[0042] Moreover, in this invention, it is having used the substrate for the thin film magnetic heads of this invention, and the thin film magnetic head of high quality and high-reliability has been offered.

[Translation done.]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] (a) And (b) is the perspective view showing the substrate for the thin film magnetic heads of this invention.

[Drawing 2] It is an important section expanded sectional view by cutting plane line X-X in drawing 1 (a).

[Drawing 3] It is the important section expanded sectional view showing the layer system of the thin film magnetic head of this invention.

[Drawing 4] It is the explanatory view showing the busy condition of the thin film magnetic head of this invention.

[Description of Notations]

1 Substrate for Thin Film Magnetic Heads

2 Thin Film Magnetic Head

3 Slider

4 MR Component

5 Media

6 Substrate

7 DLC Film

8 Amorphous Alumina Film

9 Magnetic Film

[Translation done.]

* NOTICES *

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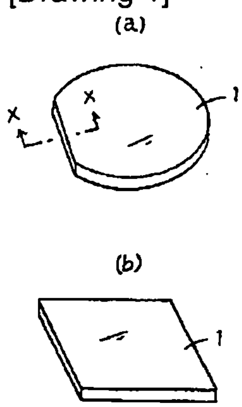
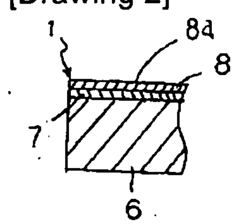
DRAWINGS

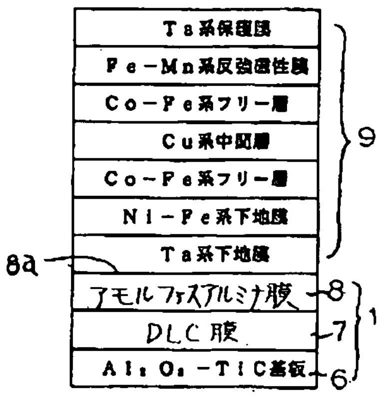
[Drawing 1]



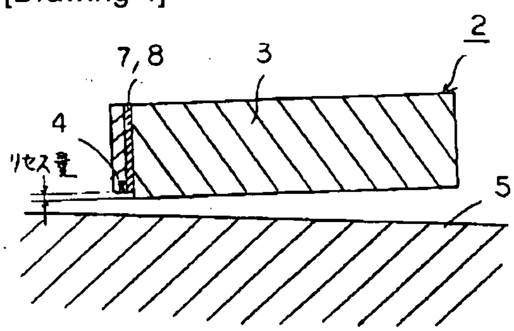
[Drawing 2]



[Drawing 3]



[Drawing 4]



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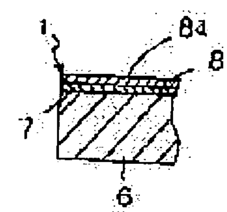
SOLUTION: A diamond-like carbon film having 0.7 to 3.5 μm thickness and an amorphous alumina film having $\leq$1.3 μm thickness are deposited successively on a substrate. First, a diamond-like carbon(DLC) film 7 is formed through normal temperature plasma CVD method on a disk substrate 6 having an orientation flat face. Then an amorphous alumina film 8 is formed through RF sputtering or ECR sputtering. The amorphous alumina film 8 formed by RF sputtering or ECR sputtering has high film packing rate. Thereby, thermal conductivity is improved by the DLC film 7, and as a result, heat can be fast transferred to a slider having high conductivity and the heat radiating property is enhanced.



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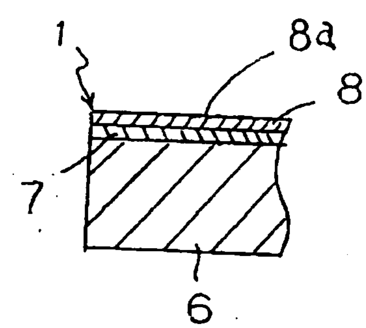
(54)【発明の名称】　薄膜磁気ヘッド用基板およびこれを用いた薄膜磁気ヘッド

(57)【要約】

【課題】薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板を提供する。

【解決手段】基板６上に厚み０．７～３．５μｍのＤＬＣ膜７と、厚み１．３μｍ以下のアモルファスアルミナ膜８とを順次積層してなる薄膜磁気ヘッド用基板１。



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【特許請求の範囲】

【請求項１】基板上に厚み０．７～３．５μmのダイヤモンド・ライク・カーボン膜と厚み１．３μm以下のアモルファスアルミナ膜とを順次積層してなる薄膜磁気ヘッド用基板。

【請求項２】請求項１の薄膜磁気ヘッド用基板のアモルファスアルミナ膜上に磁性膜を形成してなる薄膜磁気ヘッド。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はコンピューターの記録装置であるハードディスクドライブやテープドライブ等に用いられる薄膜磁気ヘッドならびにそれに用いる薄膜磁気ヘッド用基板に関するものである。

【０００２】

【従来の技術】従来、薄膜磁気ヘッド用基板には主成分としてアルミナ（Al_2O_3）およびチタンカーバイド（ＴｉＣ）の複合材からなるセラミック基板上にアモルファスアルミナからなる絶縁膜をスパッタリング法にて成膜し、その面を片面ポリッシュ機にて鏡面加工したものが用いられている。

【０００３】上記絶縁膜は導電材であるセラミック基板との絶縁性を得るため、さらに平滑性を達成するために形成するが、とくに絶縁膜の面粗さについては、その上に素子を形成するために重要であって、より平滑な面を得るためにCMP（CHEMICAL MECHANICAL POLISHING）等で加工している。

【０００４】

【発明が解決しようとする問題点】近年、記録密度を向上させるために、薄膜磁気ヘッドの素子に磁気抵抗効果を用いたMR（MAGNETRORESISTIVE）、あるいはGMR（Giant MR）が用いることが提示されているが、このようなMR素子やGMR素子の場合、読み取り感度を向上させるためにセンス電流値を上げる必要がある。

【０００５】また、ハードディスクドライブ用MRヘッドやGMRヘッドにおいては、ヘッドの浮上量が１マイクロインチ程度と小さく、ニアコンタクトに近くなってきている。そのため磁気ヘッドとメディアが接触摺動しやすく、この時の摩擦熱により薄膜磁気ヘッドのMR素子部に温度変化が生じ、その結果、読み取り感度が低減する、いわゆるサーマルアスペリティ現象が非常に大きな問題点となってきた。

【０００６】かかる問題点を解消するために、素子周りの放熱性を上げる必要があるが、そのためにアモルファスアルミナ膜の厚みを薄くして、ＭＲ素子を熱伝導の高いAl_2O_3－ＴｉＣ基板に近づけ、これによって放熱性を上げたり、もしくはAl_2O_3－ＴｉＣ基板とアモルファスアルミナ膜との硬度差によるリセスを利用し、ＭＲ素子がメディア面と衝突することを防止する等の対策がおこなわれている。

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【０００７】しかしながら、アモルファスアルミナ膜の膜厚が３μm以下になると、耐電圧の点で不十分であった。

【０００８】したがって本発明者は上記事情に鑑みて鋭意研究を重ねた結果、アモルファスアルミナ膜に比べ熱伝導性および耐電圧特性の双方ともに優れたダイヤモンド・ライク・カーボン膜を被覆させることで、かかる問題点が解消されることを見出した。

【０００９】本発明は上記知見に基づいて完成されたものであり、その目的は薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板を提供することにある。

【００１０】本発明の他の目的は本発明の薄膜磁気ヘッド用基板を用いた高品質かつ高信頼性の薄膜磁気ヘッドを提供することにある。

【００１１】

【問題点を解決するための手段】本発明の薄膜磁気ヘッド用基板は、基板上に厚み０．７～３．５μmのダイヤモンド・ライク・カーボン膜と厚み１．３μm以下のアモルファスアルミナ膜とを順次積層したことを特徴とする。

【００１２】本発明の薄膜磁気ヘッドは、本発明の薄膜磁気ヘッド用基板のアモルファスアルミナ膜上に磁性膜を形成してなることを特徴とする。

【００１３】

【発明の実施の形態】以下、本発明の実施形態を図１～図４によって説明する。図１の（ａ）および（ｂ）は本発明の薄膜磁気ヘッド用基板１を示す斜視図、図２は図１（ａ）における切断面線Ｘ－Ｘによる要部拡大断面図、図３は本発明の薄膜磁気ヘッド用基板１の上に磁性膜を形成した層構造を示す要部拡大断面図である。また、図４は本発明の薄膜磁気ヘッド２の使用状態を示す断面図である。

【００１４】図４の薄膜磁気ヘッド２において、３はAl_2O_3－ＴｉＣ系セラミックス、フェライト、サファイアなどからなるスライダ、４はMR素子、５はメディアである。

【００１５】上記薄膜磁気ヘッド２は下記の製造工程により得られる。まず、図１の薄膜磁気ヘッド用基板１によれば、（ａ）に示すようにオリエンテーションフラットを有する直径２～８インチの円板状基板６、もしくは（ｂ）に示すように一辺３～６インチの角板状基板６である。これらの基板６の上に、図２に示すようにダイヤモンド・ライク・カーボン（ＤＬＣ）膜７を常温プラズマＣＶＤ法により形成し、ついでアモルファスアルミナ膜８をＲＦスパッタ法やＥＣＲスパッタ法により形成する。ちなみに上記常温プラズマＣＶＤ法については高真空中の放電プラズマ中で炭化水素ガスを分解し、プラズ

マ中のイオン、励起分子を基板に電気的に加速し、このような高エネルギーでもって衝突させせることで形成する。

【００１６】上記ＤＬＣ膜７は炭素原子４個の結合形体においてダイヤモンドがほとんどSP_3軌道であるのに対しSP_3軌道とSP_2軌道の両方を含むものであって、表面平滑性に優れ、さらに硬度が高く、耐磨耗性に優れている。

【００１７】また、ＤＬＣ膜７はアモルファスアルミナ膜８に比べ熱伝導性が高く、さらに電気的絶縁性にも優れるが、その反面、表面性状に劣り、膜欠陥が生じやすい。さらにＤＬＣ膜７はＨＶ３０００以上の高硬度なために、表面研磨がむずかしく、表面平滑化が困難である。

【００１８】そこで、ＤＬＣ膜７の欠点を補完させるために、その上にアモルファスアルミナ膜８を形成し、これによって表面を平滑にするとともに、欠陥の発生を防止し、良好で高い耐電圧を具備させる。

【００１９】アモルファスアルミナ膜８を形成したことで、その表面８ａはきわめて滑らかな面となり、ついで図３に示すように表面８ａの上に磁性膜９を形成する。このようなウエハ工程の後に、スライシング工程、ＡＢＳ面ポリッシュ工程、イオンミリング加工（ＲＩＥ加工）を順次経て、多数の薄膜磁気ヘッド２を同時に得る。ＭＲ素子については、読み込みで使用する素子であって、フォトリソグラフによる微細加工技術で形成する。

【００２０】上記基板６をAl_2O_3－ＴｉＣ系セラミックスで作製する場合には、６０～８０％のAl_2O_3と４０～２０％のＴｉＣを主成分とする原料を用い、大気あるいは還元雰囲気中１６００～１８００℃でホットプレスあるいはＨＩＰ処理して得られる。このAl_2O_3－ＴｉＣ系セラミックスは非常に緻密な焼結体となり、表面を滑らかにすることができる。なお、Al_2O_3－ＴｉＣ系セラミックスは導電材であるが、基板６上にＤＬＣ膜７とアモルファスアルミナ膜８を形成することによって絶縁性をもたせる。

【００２１】また、アモルファスアルミナ膜８を形成した後には、膜表面をさらに平滑にすべくＣＭＰ加工するよい。

【００２２】これによって、表面はＡＦＭ（ＡＴＯＭＩＣ　ＦＯＲＣＥ　ＭＩＣＲＯＳＣＯＰＹ）で測定される表面粗度（Ｒａ）であらわすと、１０Å以下にできる。

【００２３】そして、かかる研磨後の厚みを１．３μｍ以下、好適には１μｍ以下にするとよく、これによってアモルファスアルミナ膜８を通ってＤＬＣ膜７に放熱される効率が高くなるとなる点で望ましい。

【００２４】また、ＤＬＣ膜７の厚みを０．７～３．５μｍ、好適には１～３μｍにするとよく、０．７μｍ未満の場合には耐電圧が低下し、３．５μｍを越えるとアモルファスアルミナ膜８との間で剥離する。

【００２５】かくして常温プラズマＣＶＤ法により形成したＤＬＣ膜７では、膜内および膜表面に多くの欠陥が発生しているが、さらにＲＦスパッタ法やＥＣＲスパッタ法により形成したアモルファスアルミナ膜８では高い成膜充填率が得られ、これにより、ＤＬＣ膜７でもって熱伝導性を高め、その結果、熱伝導性の高いスライダ３に熱をよりはやく伝えることができ、放熱性が高められた。

【００２６】また、ＤＬＣ膜７によって耐電圧特性も高め（ＤＬＣ膜７とアモルファスアルミナ膜８との積層に対する印加電圧１０Ｖにおける常温抵抗値は$10^{11}\Omega$以上となる）、しかも、アモルファスアルミナ膜８でもって優れた表面平滑性が得られたことで、面品位に優れた薄膜磁気ヘッド用基板１が提供された。

【００２７】

【実施例】以下、本発明の実施例を説明する。出発原料としてアルミナ（純度９９．９％、原料粉末の平均粒径：０．４μｍ）とチタンカーバイド（純度９９．５％、原料粉末の平均粒径：０．３μｍ）を使用し、アルミナが７０重量％、チタンカーバイドが３０重量％の比率となるように秤量し、さらにチタンカーバイドに対し約１０重量％の酸化チタンTiO_2を添加し、そして、アルミナボールにて混合した。ついで混合粉末を成形し、１６００℃、２５０kg/cm^2の圧力で１時間ホットプレス焼成した。

【００２８】このようにして作製した焼結体をダイヤモンドホイールにより所定の円板形状に研削加工した後、ダイヤモンド砥粒を用いて表面のラッピング加工をおこなった。ついで平均粒径０．５μｍのダイヤモンドパウダーを用いて、基板表面と研磨板あるいは研磨布を相対的に摺動させて精密研磨をおこない、これによって基板の表面粗度Ｒａを１８Åとした。本実施例では上記研磨板として錫定盤を用いた。

【００２９】つぎに下記成膜工程にともなう成膜応力に起因して基板自体が変形することから、あらかじめ成膜裏面をショットブラスト処理をおこない、基板表面の平面度を凹面に変形しておく。

【００３０】そして、表１に示すとおり、メタンガスと水素ガスを用いて、ＲＦプラズマＣＶＤ法（ＲＦ電力：５００Ｗ、ＤＣバイアス：－２５０Ｖ）によりＤＬＣ膜を１～５μｍの範囲で成膜形成した。このような膜の表面粗度Ｒａは２８～１４０Åである。

【００３１】さらに純度９９．５％のアルミナターゲットを用いてスパッタ法にて、アモルファスアルミナ膜を３μｍの厚みで成膜し、その後、球状アルミナ微粉末を純水中に懸濁させた研磨液にて鏡面加工をおこなった後、球状セリア微粉末を純水中に懸濁させた研磨液にて最終精密加工をおこない、試料Ｎｏ．１～８のとおり、厚みを変えたＤＬＣ膜と、０．５μｍ、１μｍ、１．５

μｍの厚みのアモルファスアルミナ膜（膜面表面粗度〔Ｒａ〕）との積層を形成した。なお、比較例としてＤＬＣ膜を形成しないものを表２に試料Ｎｏ．９～１２と＊して示す。

【００３２】

【表１】

試料Ｎｏ	ＤＬＣ膜の厚み（μｍ）	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜の厚み（μｍ）	表面粗度Ｒａ（Å）		加熱処理後膜剥離	抵抗値Ω
			ＤＬＣ膜	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜		
※　１	５	０．５	１４０	２．８	有	10^{13}
※　２	４	０．５	１０８	２．６	有	10^{13}
３	３	０．５	７８	２．５	無	10^{13}
４	２	０．５	５１	３．１	無	10^{13}
５	１	０．５	２８	２．７	無	10^{12}
※　６	０．５	０．５	２５	２．６	無	10^{10}
７	１	１	２９	３．３	無	10^{12}
※　８	１	１．５	２８	３．０	有	10^{13}

※印の試料Ｎｏは本発明の範囲外のものである。

【００３３】

【００３４】

※【表２】

試料Ｎｏ	ｱﾓﾙﾌｧｽｱﾙﾐﾅ膜の厚み（μｍ）	表面粗度Ｒａ（Å）	加熱処理後膜剥離	抵抗値Ω
９	４	３．１	無	10^{11}
１０	３	２．９	無	10^{9}
１１	２	３．４	無	10^{7}
１２	１	２．７	無	10^{6}

【００３５】これら各試料に対し、加熱処理後の膜剥離、ＤＬＣ膜とアモルファスアルミナ膜の表面粗度および抵抗値を測定したところ、同表に示すような結果が得られた。

【００３６】加熱処理後の膜剥離については、各試料を真空雰囲気内で６００℃の温度で加熱し、微分干渉顕微鏡（５０倍）にて成膜段階の剥離状態を確認した。また、最外表面の表面粗度はＡＦＭにて測定した。

【００３７】常温抵抗値についてはＴｉ／Ａｕの電極を膜面に２０ヶ所／φ４マイクロインチ形成し、常温で印加電圧１０Ｖでもって三端子法を用いて膜表面と、基板の裏面との間の抵抗値を測定し、最低抵抗値を求めた。

【００３８】表１に示す結果から明らかなとおり、本発明の試料Ｎｏ．３～５、７については、抵抗値は10^{12}Ω以上になり、優れた耐電圧が得られ、さらに加熱処理後に膜剥離が生じなくなり、表面粗度Ｒａは３．３Å以下になった。

【００３９】また、本発明の各試料はすでの実用化されている試料Ｎｏ．９（アモルファスアルミナ膜だけを４μｍの厚みで形成したもの）とほぼ同程度の放熱性が得られており、そこで、本発明の各試料に磁性膜を形成した各種薄膜磁気ヘッドを作製し、それぞれサーマルアスペリティ現象を調べたところ、その発生が著しく減少し、実用上何ら支障がなかった。

【００４０】しかるに試料Ｎｏ．１、２ではＤＬＣ膜が厚いので、その表面粗さが大きくなり、そのためにアモルファスアルミナ膜との間で膜剥離が発生した。また、試料Ｎｏ．６においては、ＤＬＣ膜が薄いので、抵抗値が小さくなった。さらに試料Ｎｏ．８ではアモルファスアルミナ膜が厚いので、膜剥離が発生した。

【００４１】

【発明の効果】以上のとおり、本発明においては、基板上に厚み０．７～３．５μｍのＤＬＣ膜と厚み１．３μｍ以下のアモルファスアルミナ膜とを順次積層したことで、薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板が提供できた。

【００４２】また、本発明においては、本発明の薄膜磁気ヘッド用基板を用いたことで、高品質かつ高信頼性の薄膜磁気ヘッドが提供できた。

【図面の簡単な説明】

【図１】（ａ）および（ｂ）は本発明の薄膜磁気ヘッド用基板を示す斜視図である。

【図２】図１（ａ）における切断面線Ｘ－Ｘによる要部拡大断面図である。

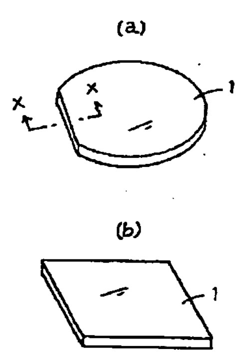
【図３】本発明の薄膜磁気ヘッドの層構造を示す要部拡大断面図である。

【図４】本発明の薄膜磁気ヘッドの使用状態を示す説明図である。

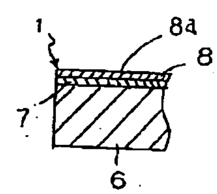
【符号の説明】

1	薄膜磁気ヘッド用基板
2	薄膜磁気ヘッド
3	スライダ
4	ＭＲ素子
5	メディア
6	基板
7	ＤＬＣ膜
8	アモルファスアルミナ膜
9	磁性膜

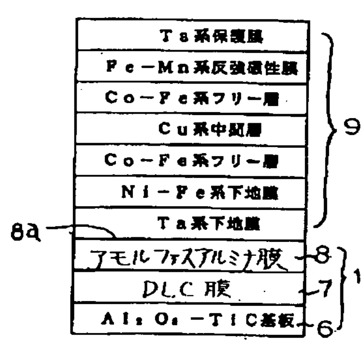
【図１】



【図２】



【図３】



【図４】